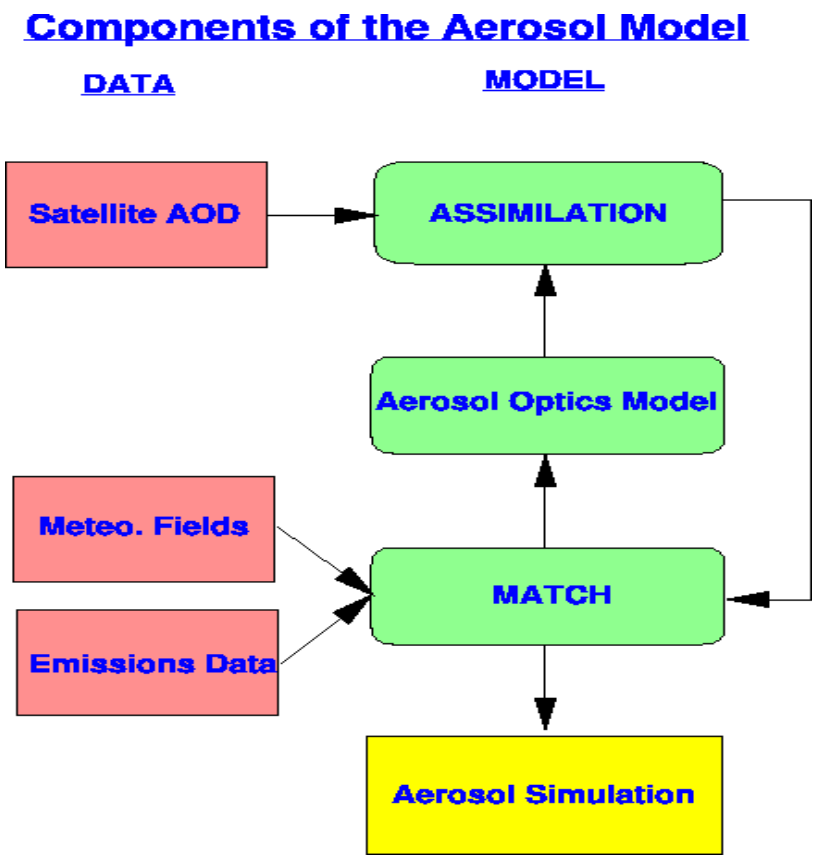
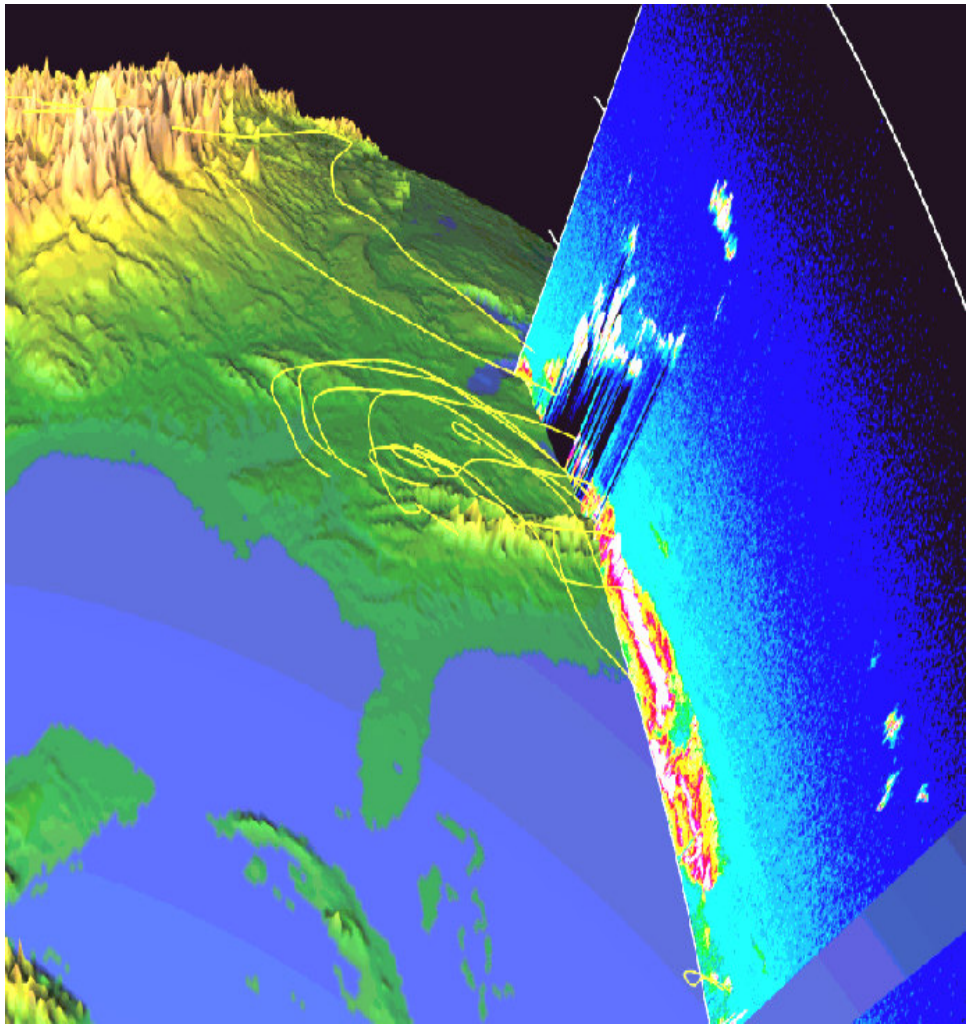
Keys to Understanding and Predicting Climate

- **Characterize external climate forcing agents**
  - — **Natural, e.g. solar variability**
  - — **Anthropogenic: greenhouse gases, aerosols (fossil fuels, biomass burning)**
    - – **Concentration**
    - – **Distribution: latitude, longitude, and altitude**
    - – **Radiative characteristics: *positive forcing* - net warming; or *negative forcing* - net cooling**

- **Use computer models to predict the response of the climate system to a change in forcing agent(s)**
  - — **Include all physical processes and feedbacks accurately; most difficult to represent: clouds**

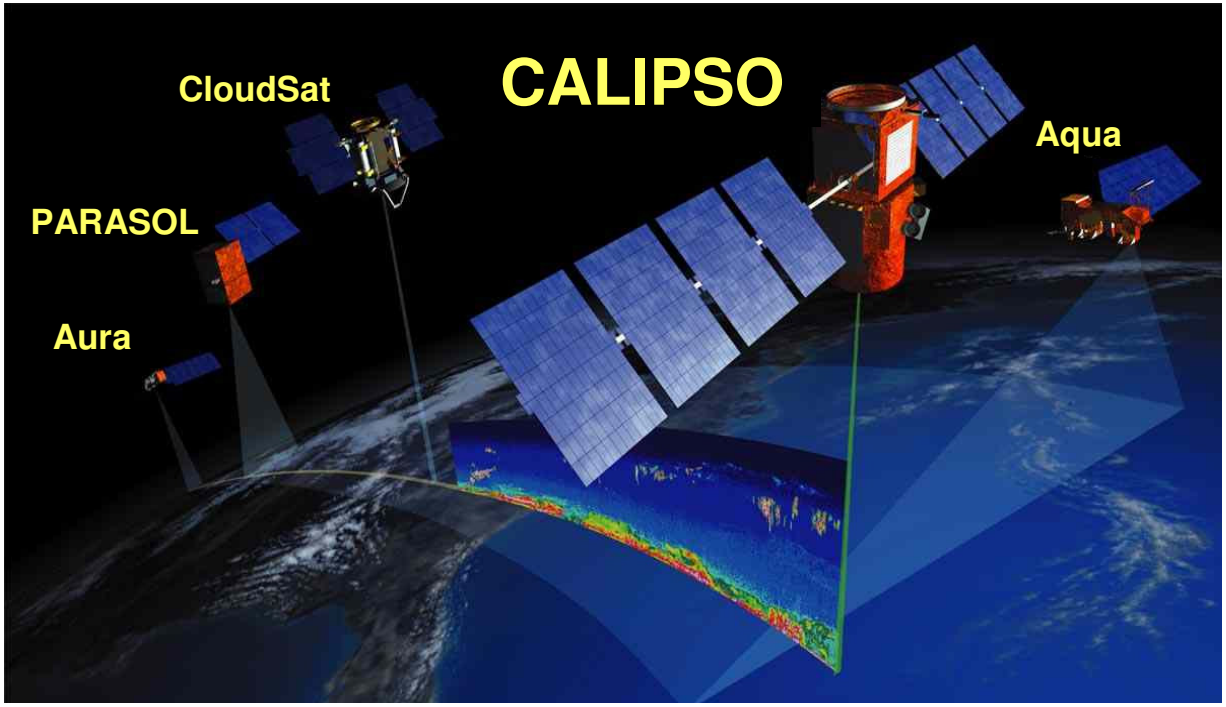
Assimilation of Lidar Aerosol Data





LITE data, Sept.1994

Mission Concept



- **Orbit:** 705 km, 98° inclination, in formation with Aqua and CloudSat
- **Launch - Early 2005**
- **Mission duration: 3 years**
- **Three co-aligned instruments:**
  - 3-channel lidar
    - 532 nm ||
    - 532 nm ⊥
    - 1064 nm

Vertical distribution of aerosols and clouds

  - Imaging IR radiometer
  - Wide-field camera

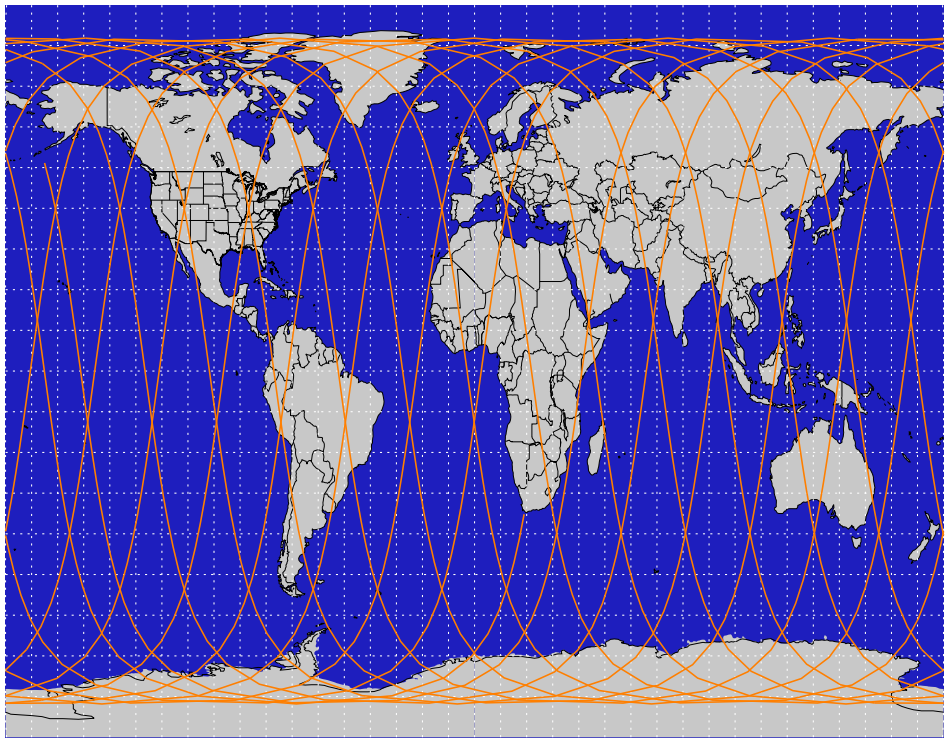
Aerosol / cloud properties

Complementary Instruments

- CloudSat radar (cloud profiles)
- Aqua CERES (top-of-the-atmosphere radiation)
- Aqua AIRS / AMSU-A / HSB (atmospheric state)
- Aqua MODIS (aerosol / cloud properties)
- PARASOL (aerosol / cloud properties)
- Aura OMI (aerosol absorption)

CALIPSO Simulated 1 Day Orbit Coverage

CALIPSO will provide global measurements of clouds and aerosols. The orange groundtracks show the locations of where CALIPSO will measure clouds and aerosols over a one day period.

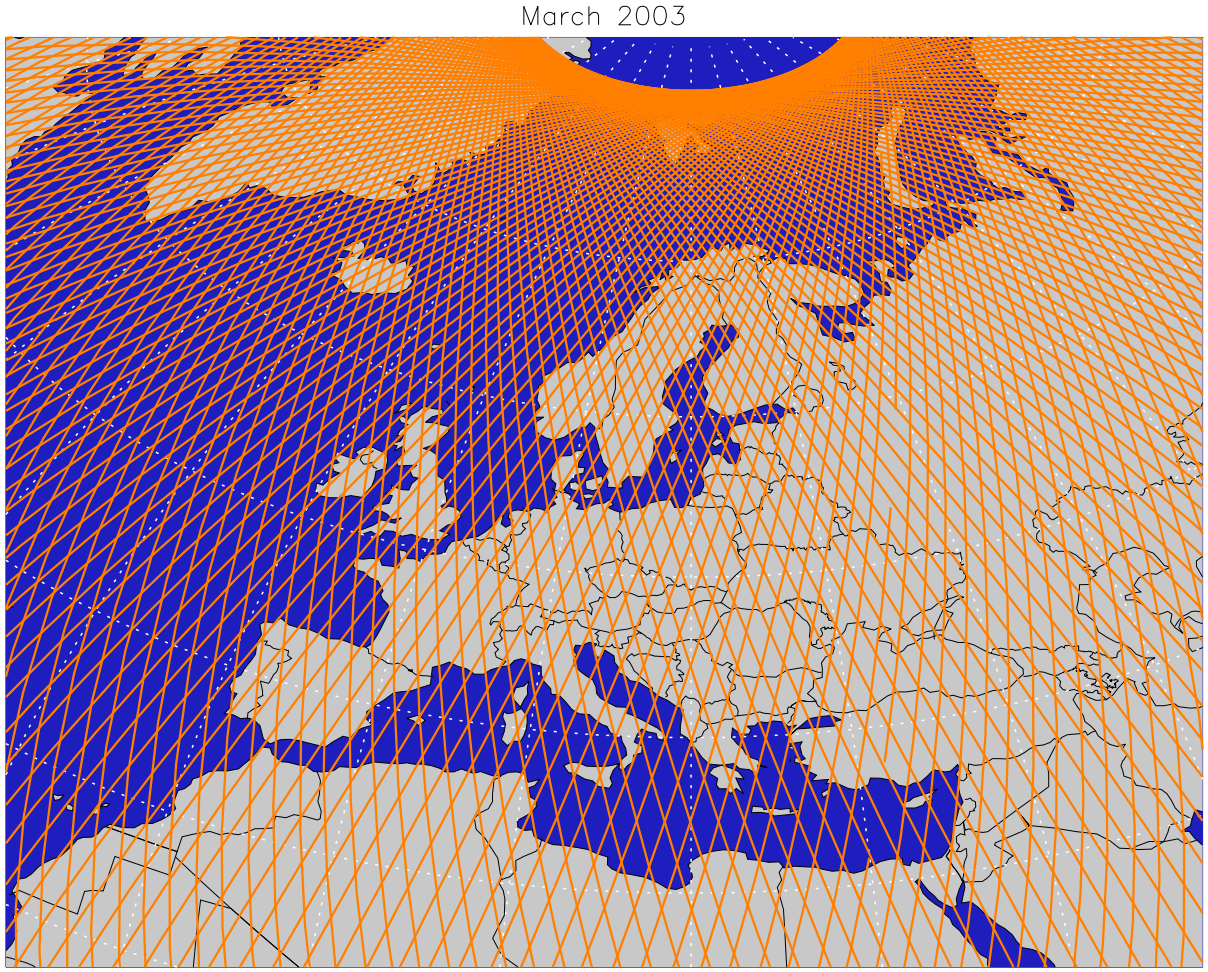


82° N

82° S

Satellite covers a fixed grid every 16 days

16-day repeat cycle produces a grid spaced by 172 km at the equator



Correlative Measurement Strategy

Quid Pro Quo (QPQ) measurements

- coordinate with established programs
- well-calibrated and characterized instrumentation
- spatial matching requirements dictate the usefulness of the sites

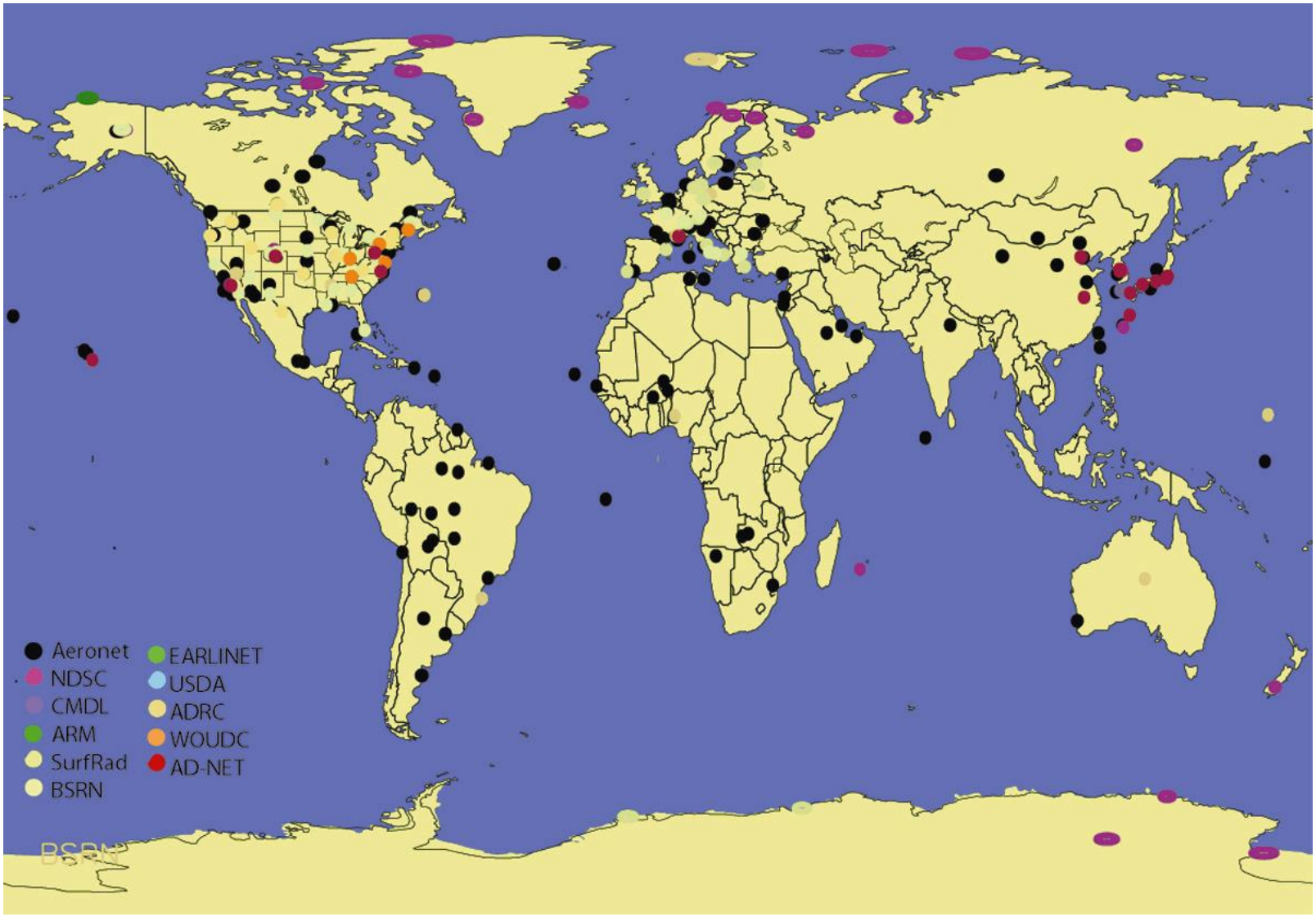
Field campaigns

- can provide comprehensive measurement suites required to fully understand the retrieval performance
- can provide spatially and temporally matched data in any location
- the number of independent samples obtained is usually limited
- need to coordinate with other NASA and international activities

Other satellites

- climatological data sets
- large number of comparisons
- coverage over regions without suitable ground sites
- limited usefulness because of uniqueness of CALIPSO measurement suite

QPQ Measurement Distribution



Collaborative Field Campaigns

Tropical West-Pacific Mission
- Jan-Mar 2005
- ER-2, WB-57, P-3, ships, ground sites

North America Outflow Study (INTEX-W)
- summer 2004/2005 and spring 2006/2007
- DC-8, P3

AURA validation missions
- 2004/05 Specific campaigns & Quarterly
- ER-2, DC-8, WB-57 (TBD)

West Africa Monsoon Field Campaign
- Apr–Oct 05 and Jan-Feb 07
- Airplanes, ground sites

Mediterranean Campaign (TBD)

Satellite Observations

MODIS

– Visible/IR τ, aerosol size information

MISR

– Visible τ, aerosol typing

PARASOL

– τ, depolarization

GLAS

– backscatter lidar 532, 1064 nm

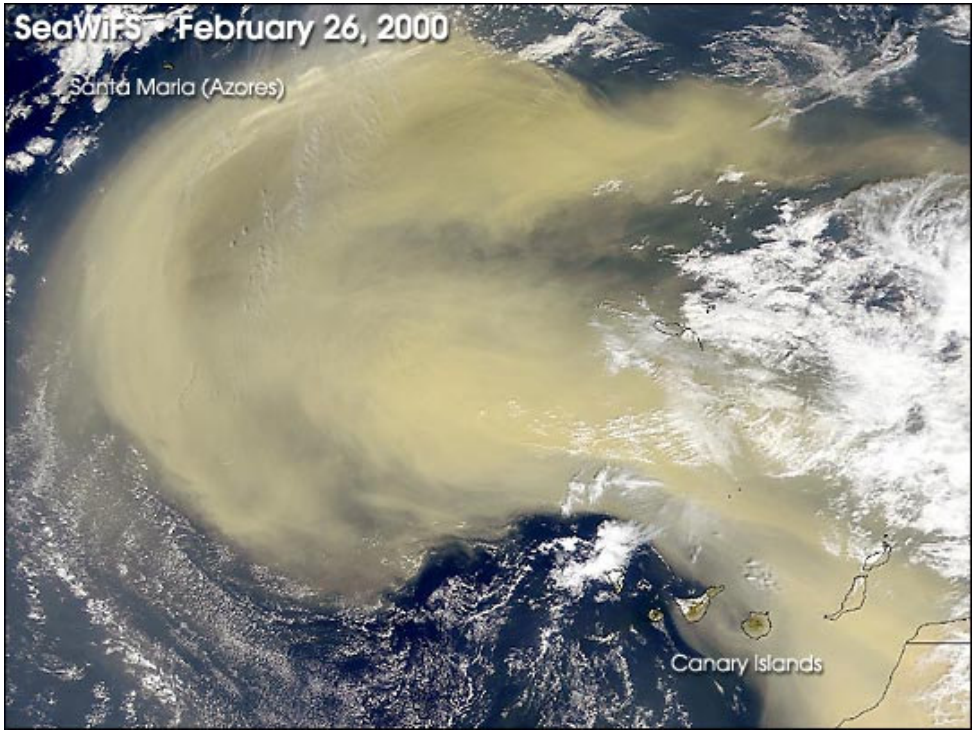
– consistency checking

SAGE III

– stratospheric τ

TOMS

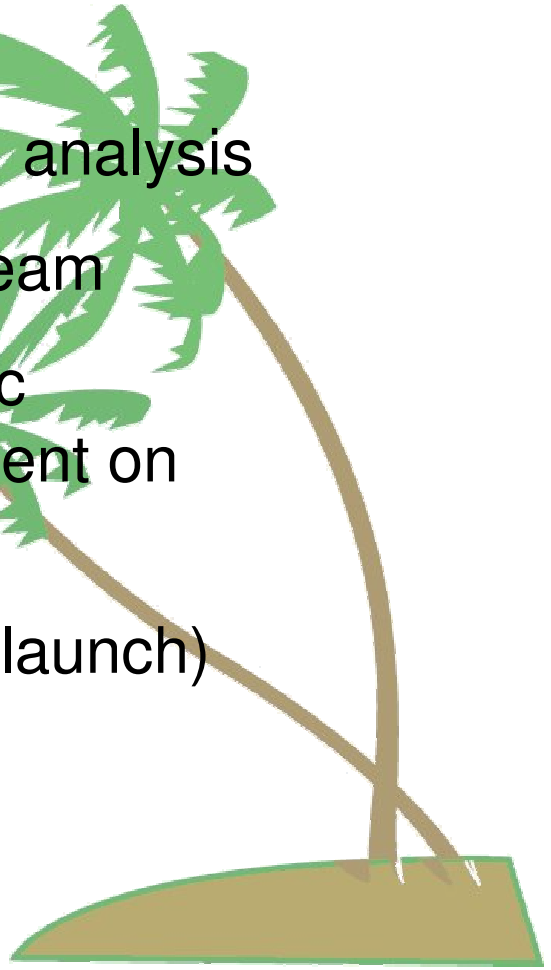
– aerosol typing



Plume of Saharan dust transported over the eastern Atlantic Ocean

Validation Activities Post Launch

- Collect and archive comparison data sets
- Conduct instrument and algorithm retrieval analysis
- Review validation analysis with Science Team
- Release Level 2 data to LaRC Atmospheric Sciences Data Center (DAAC) with statement on data quality (18 months after launch)
- Submit validation papers (18 months after launch)



Conclusion

- **CALIPSO will make important measurements of cloud and aerosol properties that will significantly improve our understanding of both direct and indirect forcing effects on climate**
- **The data sets generated by these measurements will afford the science community a unique opportunity to conduct research in Earth science**
- **Validation studies will allow the participation of a wide range of groups in CALIPSO science**
- **CALIPSO: space-based laser remote sensing of clouds and aerosols for a better understanding of climate change issues; learn more at http://www-calipso.larc.nasa.gov/**